JPRS:

28 July 1961

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- USSR -

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JPRS: 4814

CSO: 1901-S/2

THE QUESTION OF THE CENTRAL REGULATION OF THE FUNCTIONS OF THE VEGETATIVE NERVOUS SYSTEM AND THE BLOOD SYSTEM (*)

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/Following is the translation of an article by A. P. Kasatkina and Ye. L. Fal'kova of the Chair of Nervous Diseases of the Kazakh Medical Institute, in Zdravookhraneniye Kazakhstana (Public Health of Kazakhstan), Vol XXI, No 2, Alma-Ata, 1961, pages 76-80./

*Read at the First Republic Conference of Neuropathologists and Psychiatrists 27-30 June 1960.

The vegetative nervous system directly regulating all the processes of the internal vital activity of the organism is an intermediate link between the cerebral cortex and the internal organs. Being under the control of the cerebral cortex, it governs the interaction of the various vegetative functions of the organism. It is understandable, therefore, that, in disturbances of the dynamics of the cortical processes and various changes in the functional state of the central nervous system, there should occur a disorganization of the functions of the vegetative nervous system and, accordingly, of the various physiological systems of the organism (I. P. Pavlov, M. K. Petrova, K. M. Bykov, L. A. Orbeli).

There are convincing experimental data and certain clinical observations testifying that the blood system, which is directly regulated by the vegetative nervous system, is also under the control of the cerebral cortex (V. N. Chernigovskiy).

However, there have still been few clinical observations in which a simultaneous record has been made of changes in the functional state of the vegetative nervous system at its different levels and of changes in the blood system in various pathologic processes in the central nervous system.

In the present work, the following task was set: to study the functional state of the vegetative nervous system and, parallel to this, the changes in the peripheral picture of the blood in patients with disturbances of the brain blood vessels (which are the most frequent causes of functional and organic changes of varying gravity in the central nervous system).

Observations were made of 50 patients suffering from various forms of disturbances of the brain blood circulation. All the patients were divided into three groups according to the degree and persistence of the disturbance.

To the first group were assigned the patients with a transitory stage of hypertension. In them, the disease was functional in character, and organic changes were lacking in the blood vessels, internal organs and nervous system. The complaints were the most varied: headache, giddiness, roaring in the head, increased propensity to fatigue, reduction in working capacity, moodiness, disturbance of sleep, etc.

The second group was made up of patients with a more or less stable high blood pressure, who, however, as yet showed no persistent organic changes in the nervous system, but who had passing disturbances of the brain blood circulation, accompanied by non-persistent pareses or paralyses of the extremities and cranio-cerebral nerves.

To the third group were assigned patients with severe disturbances of the brain blood circulation. As a result of hemorrhagic or thrombotic seizures, persistent organic disturbances of the nervous system were developing in them in the form of paralysis and paresis of the extremities, disorders of sensitivity and affections of the cranio-cerebral nerves.

In order to assess the functional state of the vegetative nervous system, a study was made of the cerebral vegetative reflexes, the skin-temperature topography, the unconditioned vascular reflexes to temperature irritants (Ye. L. Fal'kova). In studying the functional state of the vegetative nervous system, the investigation of the skin temperature plays a very important role, since it reflects the tonic condition of the skin blood vessels and is thus an important factor in physical thermo-regulation. Examination of the skin temperature was made at 28 points on symmetric surfaces of the torso as to the dynamics of the disease, which made it possible to give a general characterization of the skin temperature by individual territories, as well as to ascertain the presence and character of temperature asymmetries.

A study was made on the same patients, by the generally accepted method, of the state of the peripheral blood and the leucocyte reactions to the ingestion of food (A. P. Kasatkina). The blood for the investigation was taken from corresponding fingers of the right and left hand.

Not having set ourselves, in the present paper, the task of discussing and analyzing all the data obtained by us on the state of the peripheral blood, we shall only report on certain changes in the leucocyte picture of the blood, which were most pronounced and most characteristic.

Our observations of healthy persons confirmed the opinion of a number of authors (L. Ya. Shargorodskiy, I. O. Gilul and Ye. L. Tsapenko) that thermo-asymmetries within limits of 0.1-0.5° do not go beyond the normal. The total number of leucocytes in persons of the control group fluctuated between 4,000 and 5,500 per cu. mm. The difference in the leucocyte content in the blood samples from the fingers of the right and left hand did not exceed 200-500 cells per cu. mm. In all patients with disturbances of the brain blood circulation there were noted pathologic asymmetries of up to 2° and even 3° C in the skin temperature, a lowering of the skin temperature in the distal sections of the extremities, a distortion of the oral-caudal coefficient and wide

fluctuations of temperature on one and the same sections of skin.

The disturbances of the skin-temperature topography were most distinct in the patients of the first group, in whom heightened excitability of the cortex [Sic. Error for kozhi, "skin"?] was noted. The total number of leucocytes in such patients fluctuated within normal figures, 4,000-6,000 per cu. mm; but in nearly half the patients distinct asymmetries were noted in the leucocyte content in the blood samples taken from the right and left fingers, reaching 1,000-2,000 per cu mm. which goes already beyond the limits of possible physiological asymmetries.

In most of the patients with transient disturbances of the brain blood circulation the total number of leucocytes was within the limits of the normal figures; only in certain patients was leucocytosis noted (7,500-9,000 per cu. mm). But, on the other hand, pronounced leucocyte asymmetries were noted in the majority of them, reaching 2,500 per cu mm, principally because of the predominance of leucocytes on the "healthy" side. On the side on which motor and sensory disturbances were noted, the numbers of leucocytes were at the lower limit of the normal or were even normal (3,000-3,500). Thereafter, the dynamics of the leucocyte asymmetries changed in the opposite direction; the number of leucocytes dropped on the "healthy" side and rose on the side where there had been pareses and disorder of the sensitivity of the past.

In patients with persistent disturbances of the brain blood circulation in the initial period of paralysis, when the process was not of long standing, the skin temperature on the paralyzed side was higher than on the healthy side, while in long-standing processes there was a tendency toward a lowering of the skin temperature on the side with the paralysis.

In the acute period of the disturbance of the brain blood circulation, caused by hemorrhagic or thrombotic seizure, leucocytosis was noted in more than half the patients (8,000-10,000 per cu mm), and sharply pronounced leucocyte asymmetries, reaching 4,000 per cu mm, were noted in all the patients. But we did not succeed in perceiving any regularity in the distribution of these asymmetries -- in half of the patients the number of leucocytes was larger on the side with the paralysis, while in the other half it was larger on the "healthy" side. Distinct tendency to leucocytosis and pronounced leucocyte asymmetries remained in most of the patients before discharge from the clinic when their condition had improved and the motor and sensory functions had been restored to a considerable extent.

In patients with residual phenomena after a seizure, the leucocyte picture of the blood was more tranquil: the total number of leucocytes was within the normal figures, the leucocyte asymmetries did not exceed 2,000 per cu mm and were mainly due to leukopenic figures on the side with the pareses and paralyses. In applying rational therapy aimed at restoring the disturbed functions of the central nervous system, the number of leucocytes on the side with the pareses and paralyses increased.

Vascular reflexes to temperature irritants were studied with

axon-reflector and repercussion tests. Normally, in the axon-reflector test, the temperature dropped 8-9 degrees C under the influence of the chilling of the skin of the forearm (water temperature 15° C, for 5 minutes), and the time necessary to restore the initial temperature to this section -- adaptation time -- was 8-10 minutes. In the patients' response to a cold irritant there were noted a lengthening of the adaptation time (to 16-25 minutes) and a change in the character of the temperature curve, which testified to the disturbance to the adaptive ability of the vessels. In the percussion test, when the finger of one hand is immersed for 5 minutes in warm water (45° C), the skin temperature on the analogous finger of the other hand correspondingly rises 1-2 degrees C in 10 minutes. In patients with disturbances of the brain blood circulation a change was noted in the response reactions to a heat irritant, which fact was manifested in torpid, negative and distorted vascular reactions.

Having noted considerable changes in the unconditioned vascular reflexes to temperature irritants, we observed in the same patients the character of the short-term reflex shifts of leucocytes taking place under the influence of the ingestion of food. Generally known is the role of impulses from the interoceptors of the alimentary canal. An increase in the number of leucocytes after a short-term leucopenic phase and following the ingestion of food bears the name of digestive leucocytosis. In the control group of practically healthly persons, upon counting the total number of leucocytes 1.5 and 3 hours after a standard breakfast, we observed two types of leucocyte reaction to a food load, conventionally called by us "mobile" and "torpid" types.

In all three groups of patients, regardless of the presence, as well as the degree and persistence of the disturbance of the brain blood circulation, there was a lack of any regularity in the dynamics of the leucocyte reactions to the food load; their direction on the right and left sides was also different and was of the most diverse character.

Our observations permit us to draw the conclusion that in all degrees of the disturbance of the brain blood circulation there are distinct changes on the part of the vegetative nervous system and the blood system. They serve as an indicator of the phase states of the cortex and the subcortical vegetative centers and of the disturbances of the normal neurodynamic interrelations between them.

Comparing the data obtained in the examination of the vegetative nervous system and the blood system, in concrete clinical forms of the disturbance of the brain blood circulation, we are able to make an assumption regarding the dependence of the vegetative functions of the central nervous system upon the dynamics of the basic nervous processes:

1) With increased excitability of the cortex and subcortex, which is a basic pathogenetic factor in the development of a transitory phase of hypertension, one bbserves pronounced changes in the vegetative functions: instability of the arterial pressure, increased reactivity and non-stability of the peripheral vessels toward thermal irritants, distinct asymmetries of skin temperature (2-3 degrees C) and leucocyte asymmetries (up to

2,000 per cu mm) with normal leucocyte content in the blood;

2) With the development, in the cerebral cortex, of foci of inhibition owing to local disturbances of the brain blood circulation of the regional-spasm type, one may observe a distortion of the vascular reflexes to thermal irritants and at the same time still more pronounced leucocyte asymmetries (up to 2,500 leucocytes per cu mm) because of the tendency to leucocytosis on the "healthy" side and leukopenia on the "sick" side. It may be assumed that leukopenia on the side with pareses and disturbances of sensitivity is one of the symptoms of "prolapsus" ("vypadeniya"): upon restoration of the disturbed functions, it is replaced by leucocytosis on the same side, which may be due to the fact that upon renewal of the blood circulation the inhibition in the respective hemisphere is replaced by stimulation according to the law of self-induction;

3) With the development, principally in one hemisphere, of persistent foci of inhibition in the cortex and subcortex, as is the case in the more severe disturbances of the brain blood circulation -- in the acute period of hemorrhagic and thrombotic seizures, one may observe inertness and inhibition of the vascular reflexes and at the same time maximally pronounced leucocyte asymmetries (up to 4,000 per cu mm), and asymmetry and disorganization of the leucocyte reactions to a food load. In this case, the number of leucocytes in the peripheral blood, the skin temperature and the direction of the vascular and leucocytic reactions (in accord, apparently, with the direction of the complex neurodynamic relationships in the central nervous system) are considerably altered, now on the side with the paralyses, now on the opposite side.

The above observations show that, in disturbances of the brain blood circulation, which undoubtedly cause a disturbance of the dynamic interrelationships between the subcortical vegetative centers and the cerebral cortex, there are always distinct changes in the functional state of the higher vegetative functions. One of the manifestations of this "chaotic" activity of the subcortex is not only the disturbance of the regulation of the vascular tonus and the vascular reactivity, but also, as a consequence thereof, considerable changes in the leucocyte picture of the blood and the distortion of the leucocyte reactions to such an irritant as a food load.

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Received on 24 August, 1960

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